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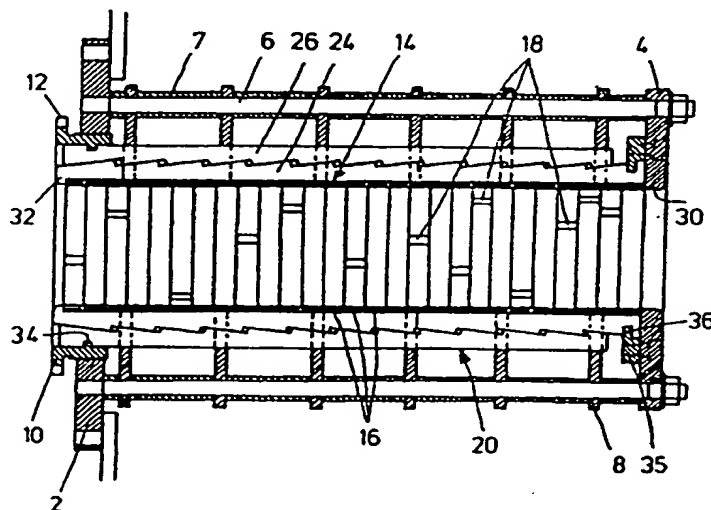
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(54) Title: A TUBULAR CALIBRATION UNIT FOR MACHINES FOR EXTRUDING PLASTIC STRINGS SUCH AS PIPES



(57) Abstract

For calibration and stabilisation of the discharge product from extruders it is known to use tubular calibration units both for calibration of the product diameter and for cooling of the product for initial stabilisation of the product, whereby the calibration pipe should have a noticeable length. For a current exact calibration it may be desirable to effect small changes of the calibration diameter, yet with associated problems in exchanging the calibration pipe. The invention provides for a calibration pipe (14) with adjustable diameter, viz. in that the pipe is made of a number of split rings (16), which are juxtaposed with random locations of the splits (18), such that the pipe when seen in its axial direction is entirely unbroken. The rings (16) may be collectively radially compressed in a controlled manner by means of axially extending wedge clamp rods (24, 26) for a uniform adjustment of the diameter of the pipe (14) as a whole.

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A TUBULAR CALIBRATION UNIT FOR MACHINES FOR EXTRUDING
PLASTIC STRINGS SUCH AS PIPES.

The present invention relates to a tubular calibration
5 unit for calibrating the outer or inner diameter of extruded
plastic string bodies such as pipes.

In the production of extruded plastic pipes it is custom-
ary that the hot plastic compound is forced through an ex-
truder nozzle, the diameter of which is somewhat larger than
10 the desired pipe diameter, the extrusion taking place to a
calibration tube unit, at the inlet of which the plastic pipe
is narrowed to the diameter of this unit, this diameter cor-
responding fully or almost to the desired pipe diameter. The
metallic calibration tube is cooled by cold water such that
15 during its throughflow the plastic compound solidifies suffi-
ciently to be stabilized with a corresponding pipe diameter
as it leaves the unit. Thereafter the pipe is passed through
a cooling zone, normally of a length larger than that of the
calibration tube, such that at the outlet from this zone the
20 pipe is stabilized sufficiently for co-operation with a pull-
ing station effecting the pull out of the pipe from its ini-
tial formation in the calibration tube. Thereafter the pipe
can be passed further to be reeled or cut into desired
lengths.

25 Normally, the production tolerances should be rather nar-
row, both for satisfying certain minimum requirements and for
achieving this without overdosage of plastic.

In practice it happens that for several reasons changes
in the process conditions may occur, such that for the de-
30 sired optimizing of the produced pipe it may be required to
use a slightly changed calibration diameter. In such cases it
is necessary to stop the process and replace the calibration
tube by another such tube with a diameter deviation of,
maybe, only one or half a millimetre.

35 Such a change, therefore, implies a production stop and
often scrapping of many meters of produced pipe, so it would
be highly desirable if it was possible to use calibration

tubes with adjustable diameter, such that required adjustments could be effected currently, during operation.

The problem has earlier been considered in connection with narrow calibration rings, confer GB-1,349,436, where it has been possible to use a split ring with such a pronounced screw shaped split that the ring, seen in the direction of throughflow, will be unbroken annular, whether it is squeezed to a more or less advanced closing of the oblique split. Also, from US-A-4,578,025 is known a construction comprising a row of mutually widely separated calibration rings provided at the outer end portions of funnel shaped elements and being controllable to undergo a more or less pronounced, resilient expansion or contraction.

These solutions, however, are unusable when it is a condition that the calibration unit be a heat/cold transferring, regular tube, preferably having a length up to several times its diameter. This is confirmed by practice, where it has been necessary to effect the said problematic total change out of the calibration tubes.

With the present invention it has been recognised that in fact it is possible to realise a calibration tube with variable diameter, viz. in that this tube is made up of a row of closely juxtaposed, split ring members, the splits of which are generally located mutually staggered in the peripheral direction, such that the tube when seen in the throughflow direction has a fully closed tubular shape; extending along this tube, axially oriented elements are provided which are controllable to effect a collective radial impact on all of the ring members for changing the operative diameter thereof. It will not be required that the splits of the single ring members be oblique, when they are only peripherally offset from each other, and there will be no question of dealing with any total resiliency of entirely closed ring elements.

Thus, a calibration tube according to the invention may, as a unit, extend over a noticeable length in both calibrating and cooling engagement with the extruded pipe, and yet be diameter adjustable in an easy and rapid manner, though of course within certain limits.

The said axially extending elements for influencing all of the rings may, in order to achieve a good stability of the calibration tube, be made as sets of co-operating wedge clamp rods, of which one may engage the rings with a straight, un-
5 broken edge, while the other may correspondingly engage a supporting structure by its opposite edge, e.g. a number of outer, rigid ring parts; when the plane of partition between the two rods is shaped as a row of sawteeth, then a mutual longitudinal displacement between the two rods will induce an
10 increase or a reduction of the total thickness of the pair of rods, all in such a manner, known per se, that large pressure forces may be transferred between the opposite exterior sides all along the length of the rods. With the use of such sets of rod elements suitably spaced along the periphery of the
15 calibration tube it is possible to achieve a ring deformation while maintaining a circular shape of the rings. All of the displaceable rod elements may in a simple manner be operated to carry out a uniform and concurrent displacement when they are all in axial engagement with an annular track in a union,
20 which is in screw connection with a cylinder member of the rigid frame structure.

In the foregoing, what is primarily referred to is a calibration unit for the outer diameter of the extruded pipe, but the principles of the invention may equally well apply to
25 tubular calibration cores for calibrating the internal diameter.

In the following the invention is described in more detail with reference to the drawing, in which:

Fig. 1 is a perspective view of a preferred embodiment of
30 a calibration unit according to the invention, for external calibration of an extruded plastic pipe, while

Fig. 2 is a longitudinal sectional view thereof.

The calibrator shown in Fig. 1 has an outer, rigid framework comprising a foremost ring flange 2 and a rearmost ring
35 flange 4 and, located therebetween, a number of peripherally mounted stay bolts 6, to which there is secured a number of plate rings 8, axially spaced by means of intermediate sleeves. The front ring flange 2 is internally threaded for

screw engagement with a bushing 10 provided with externally accessible notches 12 for operating the screw bushing.

As a main part, the calibrator comprises an inner tubular core 14 made of a plurality of juxtaposed individual rings 16, which are each of a heat resistant and resilient material such as brass or bronze and each made with a split 18 enabling each of the rings to be compressed into a diameter smaller than their natural diameter.

The entire tube core 14 is held in place by means of a number of rod elements 20 supported in radial slots 22 in the plate rings 8. These rod elements are, each, made of an interior rod 24, which abuts uniformly the outsides of all the core rings 16 along a straight inner edge, and an exterior rod 26, the straight outer edge of which rigidly abuts the outer bottoms of the radial slots 22 in the ring plates 8. At their sides or edges facing each other both of the rods 24 and 26 are provided with complementary, longish toothings, generally designated 28, enabling the radial dimension of the two rods to be varied by a mutual axial displacement of the rods.

As shown in more detail in Fig. 2, the core tube is at its outer end secured axially against an inner annular area 30 of the rear flange 4, while its front end is secured behind inwardly projecting end portions 32 of the inner rods 24, which are, themselves, at their opposite ends axially secured to the rear flange 4 by means of a holding ring 34 secured to this flange and having an inwardly projecting engagement flange portion 36.

At their front ends, the outer rods 26 are axially displaceably arranged, in being connected with the said threaded bushing 10, e.g. by a simple flange and notch connection 34 as shown.

On this background it will be understood that it is possible, by rotating the bushing 10, to provoke a longitudinal displacement of all the outer rods 26, whereby the toothings 28 thereof will slide inwardly or outwardly on the corresponding toothings of the inner rods 24, such that these will squeeze the rings 16 into a smaller or bigger diameter. The

core tube 14 will remain held in a centred manner due to the rod elements 20 being mounted evenly distributed along the periphery of the core tube.

As shown in both Fig. 1 and Fig. 2, the single rings 16 of the core tube 14 are mounted such that their individual splits 18 are generally mutually peripherally staggered. Thereby the core tube will maintain a character of a fully closed flow-through core, the diameter of which may be adjusted as desired, in a stepless manner within certain natural limits.

As also shown in both Fig. 1 and in particular in Fig. 2, the rings 16 may be provided with peripheral edge recesses 38, which in a manner known per se will enable a direct contact between the extruded pipe and the applied cooling water.

C L A I M S :

1. A tubular calibration unit for calibration of the outer or inner diameter of extruded plastic strings such as pipes, characterized in that the calibration tube is made of a row of tightly juxtaposed, split ring elements, the splits of which are located, generally, with such a staggered relationship in the peripheral direction that the tube, seen its axial direction, has a closed tubular shape; extending along the tube are arranged controllable adjustment means for collectively influencing all of the ring elements for adjusting the operative diameter of these elements and therewith of the tube as a whole.

2. A calibration unit according to claim 1, characterized in that the said controllable adjustment means are wedge clamp rod systems of the type comprising a pair of laid together rod or beam elements having interfacing oblique toothings for enabling a change of the total thickness of the rod systems by a mutual longitudinal displacement of the rod elements, these rod systems being mounted between respective generator areas of the tube formed by the ring elements and fixed support means located radially spaced therefrom on an associated carrier structure.

3. A calibration unit according to claim 2, characterized in that a first set of said clamp rods is axially anchored to the carrier structure at one end, while the other set is axially anchored to a holding member, which is in threaded connection with the holding structure.

4. A calibration unit according to claim 2, characterized in that the clamp rods extend through radial notches in a number of rigid guiding plates mounted mutually spaced along the core tube in rigid connection with the holding structure.

5. A calibration unit according to claim 4, characterized in that the guiding plates are fixed to stay bolts extending between rigid end flanges at the opposite ends of the unit.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER

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According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
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Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 1349436 A (INDUSTRIE PIRELLI S.P.A.), 3 April 1974 (03.04.74), page 1, column 2, line 67 - line 79, figure 2 --	1-5
A	EP 0670212 A1 (LÜERS, HEINRICH), 6 Sept 1995 (06.09.95), figure 1, abstract --	1-5
A	DE 2447694 A1 (KLAUS REINHOLD), 8 April 1976 (08.04.76), figures 1-3 -- -----	1-5

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

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Patent document cited in search report		Publication date	Patent family member(s)		Publication date
GB-A-	1349436	03/04/74	AR-A-	194002	12/06/73
			CA-A-	992714	13/07/76
EP-A1-	0670212	06/09/95	DE-C-	4408064	07/09/95
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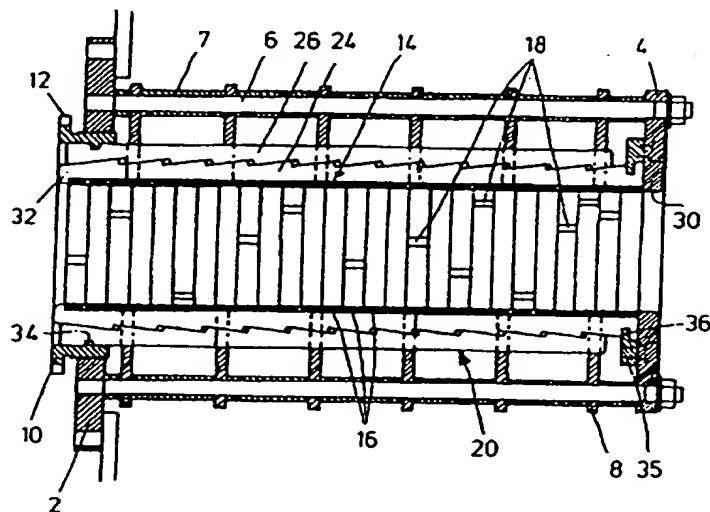
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* (Referred to in PCT Gazette No. 54/1997, Section II)

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A TUBULAR CALIBRATION UNIT FOR MACHINES FOR EXTRUDING
PLASTIC STRINGS SUCH AS PIPES.

The present invention relates to a tubular calibration
5 unit for calibrating the outer or inner diameter of extruded
plastic string bodies such as pipes.

In the production of extruded plastic pipes it is custom-
ary that the hot plastic compound is forced through an ex-
truder nozzle, the diameter of which is somewhat larger than
10 the desired pipe diameter, the extrusion taking place to a
calibration tube unit, at the inlet of which the plastic pipe
is narrowed to the diameter of this unit, this diameter cor-
responding fully or almost to the desired pipe diameter. The
metallic calibration tube is cooled by cold water such that
15 during its throughflow the plastic compound solidifies suffi-
ciently to be stabilized with a corresponding pipe diameter
as it leaves the unit. Thereafter the pipe is passed through
a cooling zone, normally of a length larger than that of the
calibration tube, such that at the outlet from this zone the
20 pipe is stabilized sufficiently for co-operation with a pull-
ing station effecting the pull out of the pipe from its ini-
tial formation in the calibration tube. Thereafter the pipe
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row, both for satisfying certain minimum requirements and for
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in the process conditions may occur, such that for the de-
30 sired optimizing of the produced pipe it may be required to
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is necessary to stop the process and replace the calibration
tube by another such tube with a diameter deviation of,
maybe, only one or half a millimetre.

35 Such a change, therefore, implies a production stop and
often scrapping of many meters of produced pipe, so it would
be highly desirable if it was possible to use calibration

tubes with adjustable diameter, such that required adjustments could be effected currently, during operation.

The problem has earlier been considered in connection with narrow calibration rings, confer GB-1,349,436, where it has been possible to use a split ring with such a pronounced screw shaped split that the ring, seen in the direction of throughflow, will be unbroken annular, whether it is squeezed to a more or less advanced closing of the oblique split. Also, from US-A-4,578,025 is known a construction comprising a row of mutually widely separated calibration rings provided at the outer end portions of funnel shaped elements and being controllable to undergo a more or less pronounced, resilient expansion or contraction.

These solutions, however, are unusable when it is a condition that the calibration unit be a heat/cold transferring, regular tube, preferably having a length up to several times its diameter. This is confirmed by practice, where it has been necessary to effect the said problematic total change out of the calibration tubes.

With the present invention it has been recognised that in fact it is possible to realise a calibration tube with variable diameter, viz. in that this tube is made up of a row of closely juxtaposed, split ring members, the splits of which are generally located mutually staggered in the peripheral direction, such that the tube when seen in the throughflow direction has a fully closed tubular shape; extending along this tube, axially oriented elements are provided which are controllable to effect a collective radial impact on all of the ring members for changing the operative diameter thereof. It will not be required that the splits of the single ring members be oblique, when they are only peripherally offset from each other, and there will be no question of dealing with any total resiliency of entirely closed ring elements.

Thus, a calibration tube according to the invention may, as a unit, extend over a noticeable length in both calibrating and cooling engagement with the extruded pipe, and yet be diameter adjustable in an easy and rapid manner, though of course within certain limits.

The said axially extending elements for influencing all of the rings may, in order to achieve a good stability of the calibration tube, be made as sets of co-operating wedge clamp rods, of which one may engage the rings with a straight, un-
5 broken edge, while the other may correspondingly engage a supporting structure by its opposite edge, e.g. a number of outer, rigid ring parts; when the plane of partition between the two rods is shaped as a row of sawteeth, then a mutual longitudinal displacement between the two rods will induce a
10 increase or a reduction of the total thickness of the pair of rods, all in such a manner, known per se, that large pressure forces may be transferred between the opposite exterior sides all along the length of the rods. With the use of such sets of rod elements suitably spaced along the periphery of the
15 calibration tube it is possible to achieve a ring deformation while maintaining a circular shape of the rings. All of the displaceable rod elements may in a simple manner be operated to carry out a uniform and concurrent displacement when they are all in axial engagement with an annular track in a union,
20 which is in screw connection with a cylinder member of the rigid frame structure.

In the foregoing, what is primarily referred to is a calibration unit for the outer diameter of the extruded pipe, but the principles of the invention may equally well apply to
25 tubular calibration cores for calibrating the internal diameter.

In the following the invention is described in more detail with reference to the drawing, in which:

Fig. 1 is a perspective view of a preferred embodiment of
30 a calibration unit according to the invention, for external calibration of an extruded plastic pipe, while

Fig. 2 is a longitudinal sectional view thereof.

The calibrator shown in Fig. 1 has an outer, rigid framework comprising a foremost ring flange 2 and a rearmost ring
35 flange 4 and, located therebetween, a number of peripherally mounted stay bolts 6, to which there is secured a number of plate rings 8, axially spaced by means of intermediate sleeves. The front ring flange 2 is internally threaded for

screw engagement with a bushing 10 provided with externally accessible notches 12 for operating the screw bushing.

As a main part, the calibrator comprises an inner tubular core 14 made of a plurality of juxtaposed individual rings 16, which are each of a heat resistant and resilient material such as brass or bronze and each made with a split 18 enabling each of the rings to be compressed into a diameter smaller than their natural diameter.

The entire tube core 14 is held in place by means of a number of rod elements 20 supported in radial slots 22 in the plate rings 8. These rod elements are, each, made of an interior rod 24, which abuts uniformly the outsides of all the core rings 16 along a straight inner edge, and an exterior rod 26, the straight outer edge of which rigidly abuts the outer bottoms of the radial slots 22 in the ring plates 8. At their sides or edges facing each other both of the rods 24 and 26 are provided with complementary, longish toothings, generally designated 28, enabling the radial dimension of the two rods to be varied by a mutual axial displacement of the rods.

As shown in more detail in Fig. 2, the core tube is at its outer end secured axially against an inner annular area 30 of the rear flange 4, while its front end is secured behind inwardly projecting end portions 32 of the inner rods 24, which are, themselves, at their opposite ends axially secured to the rear flange 4 by means of a holding ring 34 secured to this flange and having an inwardly projecting engagement flange portion 36.

At their front ends, the outer rods 26 are axially displaceably arranged, in being connected with the said threaded bushing 10, e.g. by a simple flange and notch connection 34 as shown.

On this background it will be understood that it is possible, by rotating the bushing 10, to provoke a longitudinal displacement of all the outer rods 26, whereby the toothings 28 thereof will slide inwardly or outwardly on the corresponding toothings of the inner rods 24, such that these will squeeze the rings 16 into a smaller or bigger diameter. The

core tube 14 will remain held in a centred manner due to the rod elements 20 being mounted evenly distributed along the periphery of the core tube.

As shown in both Fig. 1 and Fig. 2, the single rings 16
5 of the core tube 14 are mounted such that their individual splits 18 are generally mutually peripherally staggered. Thereby the core tube will maintain a character of a fully closed flow-through core, the diameter of which may be adjusted as desired, in a stepless manner within certain natural limits.
10

As also shown in both Fig. 1 and in particular in Fig. 2, the rings 16 may be provided with peripheral edge recesses 38, which in a manner known per se will enable a direct contact between the extruded pipe and the applied cooling water.
15

C L A I M S :

1. A tubular calibration unit for calibration of the outer or inner diameter of extruded plastic strings such as pipes, characterized in that the calibration tube is made of a row of tightly juxtaposed, split ring elements, the splits of which are located, generally, with such a staggered relationship in the peripheral direction that the tube, seen its axial direction, has a closed tubular shape; extending along the tube are arranged controllable adjustment means for collectively influencing all of the ring elements for adjusting the operative diameter of these elements and therewith of the tube as a whole.

2. A calibration unit according to claim 1, characterized in that the said controllable adjustment means are wedge clamp rod systems of the type comprising a pair of laid together rod or beam elements having interfacing oblique toothings for enabling a change of the total thickness of the rod systems by a mutual longitudinal displacement of the rod elements, these rod systems being mounted between respective generator areas of the tube formed by the ring elements and fixed support means located radially spaced therefrom on an associated carrier structure.

3. A calibration unit according to claim 2, characterized in that a first set of said clamp rods is axially anchored to the carrier structure at one end, while the other set is axially anchored to a holding member, which is in threaded connection with the holding structure.

4. A calibration unit according to claim 2, characterized in that the clamp rods extend through radial notches in a number of rigid guiding plates mounted mutually spaced along the core tube in rigid connection with the holding structure.

5. A calibration unit according to claim 4, characterized in that the guiding plates are fixed to stay bolts extending between rigid end flanges at the opposite ends of the unit.

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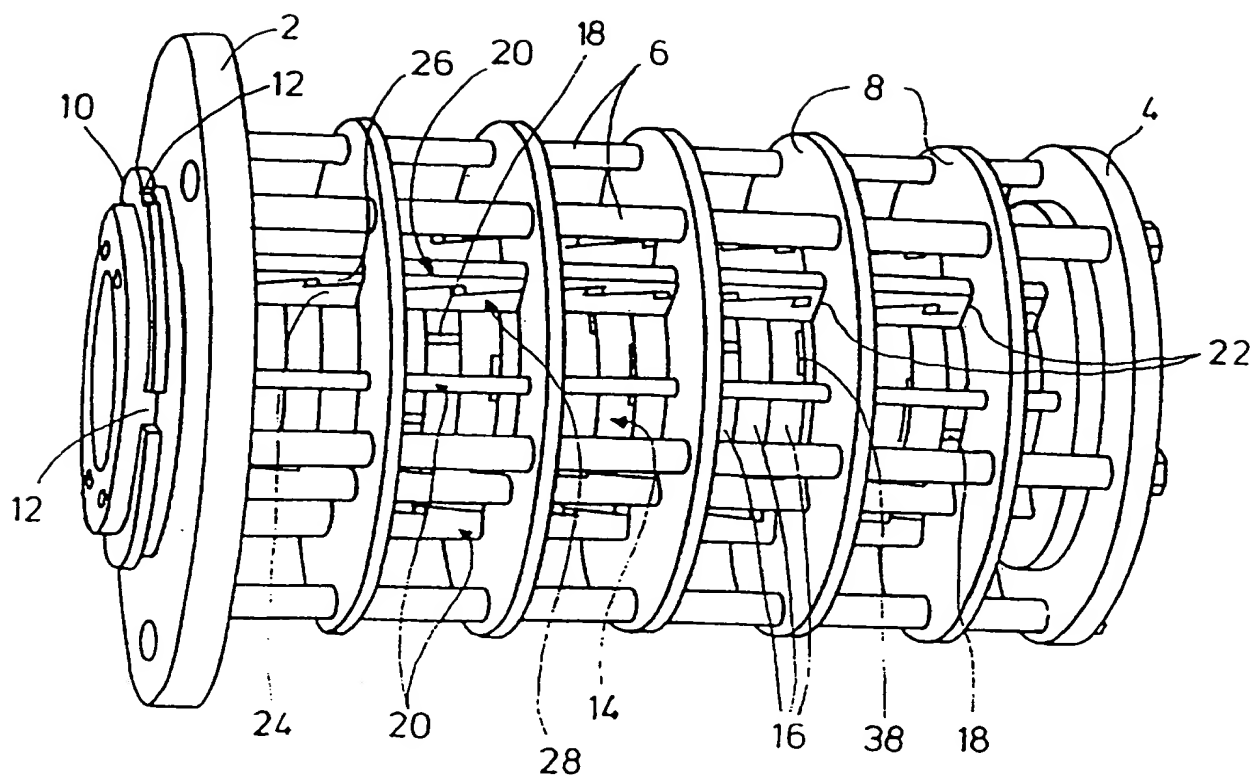


FIG.1

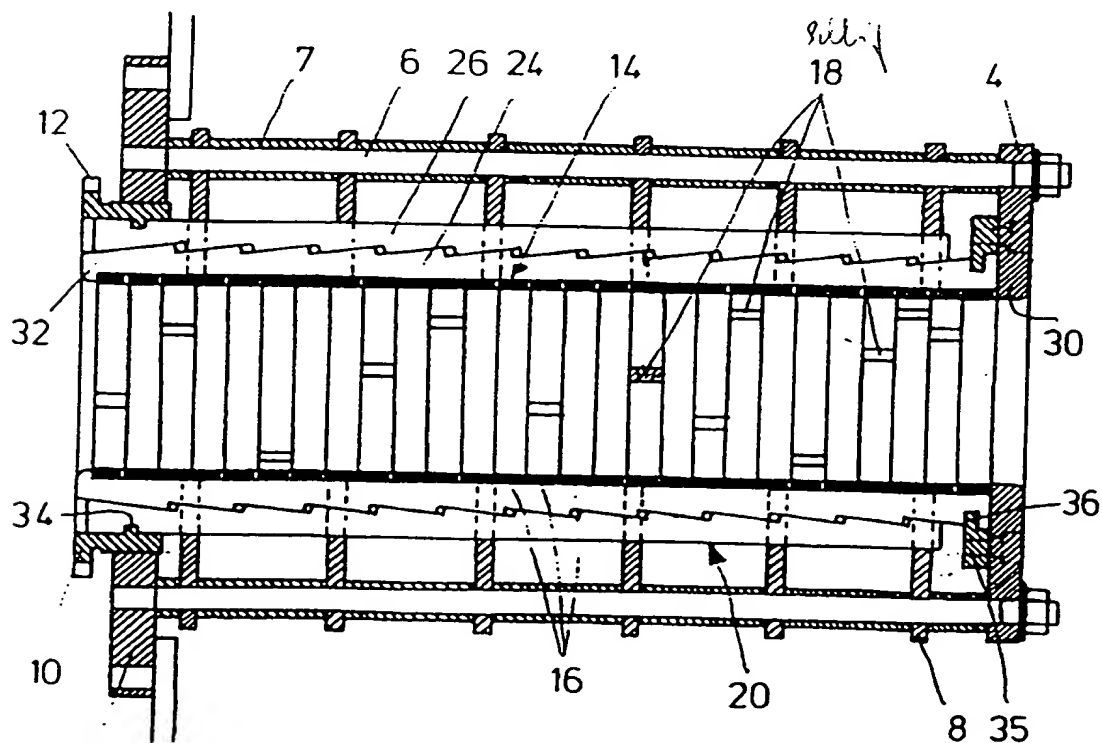


FIG.2

SUBSTITUTE SHEET (RULE 26)

INTERNATIONAL SEARCH REPORT

International application No.
PCT/DK 96/00220

A. CLASSIFICATION OF SUBJECT MATTER

IPC6: B29C 47/90

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC6: B29C

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
SE,DK,FI,NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 1349436 A (INDUSTRIE PIRELLI S.P.A.), 3 April 1974 (03.04.74), page 1, column 2, line 67 - line 79, figure 2 --	1-5
A	EP 0670212 A1 (LÜERS, HEINRICH), 6 Sept 1995 (06.09.95), figure 1, abstract --	1-5
A	DE 2447694 A1 (KLAUS REINHOLD), 8 April 1976 (08.04.76), figures 1-3 -- -----	1-5

☐ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

- *A* document defining the general state of the art which is not considered to be of particular relevance
- *B* earlier document but published on or after the international filing date
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- *O* document referring to an oral disclosure, use, exhibition or other means
- *P* document published prior to the international filing date but later than the priority date claimed

T later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

X document of particular relevance: the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

Y document of particular relevance: the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

Z document member of the same patent family

Date of the actual completion of the international search

26 August 1996

Date of mailing of the international search report

29 -08- 1996

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Information on patent family members

International application No.

PCT/DK 96/00220

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
GB-A- 1349436	03/04/74	AR-A- 194002 CA-A- 992714	12/06/73 13/07/76
EP-A1- 0670212	06/09/95	DE-C- 4408064	07/09/95
DE-A1- 2447694	08/04/76	NONE	